

Pilot drill, step drill and drill set for dental implantologyField of application of the invention

The present invention relates to a pilot drill, a step drill and a drill set formed by them for use in dental implantology. The pilot drill serves for producing a pilot bore in the form of a blind hole, to be introduced into a human jawbone as preparation for its enlargement into a step bore, which takes place with a different step drill or – if the step bore is to be enlarged further – with a number of different step drills. The prepared step bore is intended for receiving a dental implant, preferably in the form of a screw. In the case of implants in the form of screws, the prepared borehole can be provided with an internal thread before application or the implant is self-tapping, whereby the internal thread is cut into the jawbone as the implant is screwed in. The present invention relates primarily to dental implants in the form of screws. When it has become incorporated, the implant forms the anchorage for a superstructure to be built up.

Prior art

Various solutions are known for preparing the receiving bore as an implant bed. In the case of SCHROEDER, A; SUTTER, F; BUSER, D; KREKELER, G: Oral Implantology. Georg Thieme Verlag Stuttgart, second edition, 1996, page 153 et seq., Figure 7.42c, a drill set comprising a rose-headed drill and three spiral drills with increasing cross sections is shown. The rose-headed drill serves here for marking the position on the cortical bone where the bore is to be introduced. The cortical and cancellous bone are drilled open virtually continuously with the first spiral drill.

Wieland Dental + Technik GmbH & Co. KG, D-75179 Pforzheim, Germany, offers a drill sequence for a self-tapping screw implant with a 3.3 mm diameter, conical neck portion, comprising the following drilling instruments:

- a) an initial drill for accurate spot-drilling of the position;
- b) a 1.8 mm diameter spiral drill for the preparation of the bore in its full depth;
- c) a 1.8/2.5 mm diameter step drill for the widening of the mouth of the bore to a diameter of 2.5 mm;

- d) a 2.5 mm diameter spiral drill for the widening of the bore over the entire depth to a diameter of 2.5 mm; and
- e) a conical drill with a 2.5 mm diameter guide for the widening of the mouth of the bore.

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In the application of an implant with a diameter of 5.5 mm, up to four further drills are used. Before the next-larger drill is used, the existing bore is widened over a short region of its mouth to the diameter of the next-larger diameter, in order to ensure optimum centering of the following drill. Or the following drills increase in diameter only slightly. This has the consequence that many drilling instruments and working steps are necessary.

Implant Innovation Inc., USA, offers a drill set where the existing bore is also widened over a short region of its mouth to the next-higher diameter before the next-larger drill is used, in order to ensure good centering of the following drill. For this purpose, step drills are used in each case. These step drills apically have a round nose of the diameter of the previous drill, which brings about the centering in the bore and does not have a cutting function. This system requires a step drill and the corresponding spiral drill for each drilling diameter, so that a relatively great number of drilling instruments and working steps also occur here.

Finally, a series of drills is also known from FRIADENT GmbH, D-68229 Mannheim, Germany. For example for a self-tapping, 3-stage, 5.5 mm diameter screw implant, the following drills are used:

- a) a 2.0 mm diameter pilot drill for the exact spot-drilling of the position and predetermination of the axial direction;
- b) a 3.4 mm diameter rose-headed drill for the widening of the mouth of the bore to a diameter of 3.4 mm;
- c) a 3-stage step milling cutter for the preparation of a 3-stage, 3.4 mm diameter bore;
- d) a 3-stage step milling cutter for the preparation of a 3.8 mm diameter bore;

- e) a 3-stage step milling cutter for the preparation of a 4.5 mm diameter bore;
and
- f) a 3-stage step milling cutter for the preparation of a 5.5 mm diameter bore.

5 The special 3-stage geometry of the implant made this a system in which the 3-stage form of the implant is already prepared after the second drilling and this form is enlarged with each further step. Depending on the diameter of the implant, the bore is widened by repeated use of the step milling cutter. On account of the multistage geometry, however, a special set of step milling
10 cutters is required for each length of implant. Here, too, this leads to a multiplicity of instruments and, moreover, 3-stage milling cutters are much more expensive.

With all the drill sequences mentioned, a usually short bore is initially made in
15 the cortical bone in order to fix the position for the following drill, which is then used to predetermine the exact direction and then successively widen the bore. All the drill systems presented require more working steps – drilling operations and drill changes – as different drill diameters are to be provided, which causes an increased time requirement, complicates the operational procedure, requires
20 a relatively great number of different instruments and also increases the risk of mistakes.

Object of the invention

In view of the shortcomings of the existing drilling tools, the object is based on
25 providing an improved pilot drill. A further object is to provide an improved step drill. An additional object is to propose a multipart drill set, comprising the pilot drill and the step drill, which can be used advantageously. It is to be assumed here that the bore introduced penetrates the cortical bone with great locational precision at the intended place, in order to ensure a correct position of the
30 implant and consequently of the later tooth replacement. The direction of the bore must be exactly aligned, in order to absorb optimally the loads later acting on the tooth replacement. In the preparation of the implant bed, the jawbone is

to be subjected to as little stress as possible. It must be possible for the preparation of the bore to take place in a simple and time-saving manner with few manipulations; only a small number of instruments are to be required for this. Finally, the total costs incurred are to be kept down.

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Overview of the invention

For the preparation of the implant bed for receiving a dental implant – as a step bore in the form of a blind hole to be introduced in the human jawbone - a pilot drill is provided. The pilot drill has at its apical end a pilot tip with tip cutting
10 edges. Extending from the pilot tip in the direction of the coronal end of the pilot drill is a pilot guide, above which there lies a drill neck, which has a larger drill diameter than the drill diameter of the pilot guide. The drill neck is adjoined by a drill stem, and the pilot drill has at the coronal end a standardized dental coupling, as is customary for dental handpieces on electric drilling engines. On
15 the side of the pilot guide there is at least one guide cutting edge. In the transition from the pilot guide to the drill neck there is a step with at least one step cutting edge. Along the pilot drill there extends at least one spiral groove and an adjacent bevel. The pilot drill is characterized firstly in that the tip cutting edges at the pilot tip are sharply formed and center-cutting and chamfers extend from
20 the tip cutting edges upward of the pilot guide. The step cutting edges at the step are formed in a cutting manner, while the guide cutting edges are of a blunt, that is to say non-cutting, form.

The following features represent advantageous embodiments of the invention:
25 the drill neck with the bevel is formed in a weakly cutting manner. The pilot guide has a length in the range from 1.0 mm to 4.0 mm, for example 3.0 mm. The pilot drill is preferably formed with two cutting edges and consequently has two tip cutting edges, two chamfers, two guide cutting edges, two spiral grooves, two bevels and two step cutting edges. The drill neck has a length at
30 least equal to the depth of insertion of the implants to be applied. The pilot guide has a diameter in the region of 1.5 mm and the drill neck has a diameter in the region of 2.0 mm. The tip angle lying between the tip cutting edges is less

than 90°; it preferably lies in the region of 80°. The spiral grooves extent continuously from the coronal end of the drill neck into the pilot tip, the spiral grooves having at the pilot tip only a fraction of their full cross section, as present at the drill neck, as a result of the smaller diameter. A number of visible
5 depth markings are provided at equal or unequal intervals on the drill neck for checking the depth of penetration of the pilot drill.

The pilot guide with the pilot tip is intended for fixing the position of the step bore to be produced with the introduction of a start of a pilot bore through the
10 cortical bone of the jawbone, the start comprising a pilot bore guide and a pilot bore tip. The step is intended for generating a noticeably increased drilling resistance once the cortical bone is penetrated – with completion of the pilot bore guide and tip –, so that this indication allows a surgeon to check the drilling direction that has been set up. The blunt guide cutting edges make it possible
15 to correct the drilling direction within a conical range of correction without widening the pilot bore guide. The drill neck with its dimensioning is intended to create the pilot bore with the final depth.

For the enlargement of a pilot bore in the form of a blind hole previously introduced into a human jawbone into a step bore or for further enlarging an existing
20 step bore into a further enlarged step bore as a receptacle for a dental implant, a step drill is provided. The step drill has a step tip, which lies at the apical end of the step drill and is provided with tip cutting edges. A step guide extends from the step tip in the direction of a coronal end of the step drill. Above the
25 step guide lies a drill neck, which has a larger drill diameter than the drill diameter of the step guide. The drill neck is adjoined by a drill stem, and at the coronal end of the step drill lies a standardized dental coupling for adaptation in a dental handpiece of an electric drilling engine. The step bore has at least one guide cutting edge lying to the side of the step guide. At the transition from the
30 step guide to the drill neck, a step with at least one step cutting edge is formed. Over the step drill there extends at least one spiral groove and an adjacent bevel. The step drill is characterized firstly in that the tip cutting edges at the

step tip are sharply formed and chamfers extend from the tip cutting edges upward of the step guide. The step cutting edges at the step are formed in a cutting manner, while the guide cutting edges are blunt, that is to say non-cutting.

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The following features represent advantageous embodiments of the invention: the drill neck with the bevel is formed in a weakly cutting manner. The step guide has a length in the region of 2.0 mm. The step drill is preferably formed with three cutting edges and consequently has three tip cutting edges, three
10 chamfers, three guide cutting edges, three spiral grooves, three bevels and three step cutting edges. The drill neck has a length at least equal to the depth of insertion of the implant to be applied. The step guide of different step drills, that is the *first*, *second* and *third* step drills, has a diameter in the region of 2.0 mm, 2.8 mm and 3.5 mm, respectively, and the drill neck of these *first*, *second*
15 and *third* step drills has the associated diameter in the region of 2.8 mm, 3.5 mm and 4.3 mm, respectively. The tip angle formed between the tip cutting edges is greater than 90°; it preferably lies in the region of 120°.

The spiral grooves extend continuously from the coronal end of the drill neck
20 into the step tip, the spiral grooves having at the step guide only a fraction of their full cross section, as present at the drill neck, as a result of the smaller diameter. A number of visible depth markings are provided at equal or unequal intervals on the drill neck for checking the depth of penetration. The step guide with the step tip and the blunt guide cutting edges is intended for centering the
25 step drill when setting it up in the pilot bore or step bore and guiding it in a centered manner when advancing along the pilot bore or the step bore. The step with the step cutting edges is intended for widening the pilot bore with the previous diameters to new diameters or for widening the step bore with the previous diameters to the new diameters.

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For the preparation and creation of an implant bed for receiving a dental implant in a step bore in the form of a pilot bore in the form of a blind hole, to be

introduced into a human jawbone, a drill set is provided, comprising firstly a previously described pilot drill for making a pilot bore. The drill set also includes at least a *first*, previously described, step drill for the enlargement of the existing pilot bore into a step bore. The drill set is completed by an optional, *second*,
5 previously described, step drill for the second enlargement of an existing step bore into a further enlarged step bore. Finally, the drill set may include an optional, *third*, previously described, step drill for the third enlargement of the already twice-enlarged step bore into a step bore enlarged a final time.

10 Brief description of the accompanying drawings

The detailed description of an exemplary embodiment of the arrangement according to the invention follows, with reference to the accompanying drawings, in which:

- 15 Figure 1A shows a pilot drill according to the invention;
Figure 1B shows the enlarged detail X1 from Figure 1A, with the tip of the pilot drill;
- Figure 2A shows a *first* step drill according to the invention, with the smallest
20 diameter;
Figure 2B shows the enlarged detail X2 from Figure 2A, with the tip of the *first* step drill;
- Figure 3A shows a *second* step drill, with a medium diameter;
25 Figure 3B shows the enlarged detail X3 from Figure 3A, with the tip of the *second* step drill;
- Figure 4A shows a *third* step drill, with the largest diameter;
Figure 4B shows the enlarged detail X4 from Figure 4A, with the tip of the
30 *third* step drill;
- Figure 5 shows a depth gage for the pilot drill according to Figure 1A;
Figure 6 shows a depth gage for the *first* step drill according to Figure 2A;

Figure 7 shows a depth gage for the *second* step drill according to Figure 3A;

Figure 8 shows a depth gage for the *third* step drill according to Figure 4A;

Figure 9 shows a dental implant known per se for insertion in a bore produced with the *first* step drill according to Figure 2A;

Figures 10 to 13

show the basic operational handling of the drill set, beginning with the initial situation according to Figure 10, step 1, up to creation of the finished bore according to Figure 11, step 10 (for the smallest implant diameter); Figure 12, step 14 (for the medium implant diameter); Figure 13, step 18 (for the largest implant diameter);

Figure 10:

Step 1 - producing the pilot guide in the cortical bone with the pilot drill according to Figure 1A;

Step 2 - visual checking of the position of the pilot guide produced;

Step 3 - insertion of the pilot drill into the existing pilot guide and definitive determination of the drilling direction;

Step 4 - producing the pilot bore with full drilling depth;

Step 5 - checking the drilling depth with the depth gage according to Figure 5 for the pilot drill;

Step 6 - visual checking of the pilot bore produced;

Figure 11:

Step 6 - visual checking of the pilot bore produced (taking over Figure 10, step 6);

Step 7 - insertion of the *first* step drill according to Figure 2A into the existing pilot bore;

Step 8 - producing the *first* step bore to the full drilling depth;

Step 9 - checking the drilling depth with the depth gage according to Figure 6 for the *first* step drill;

Step 10 - visually checking the *first* step bore produced;

Step 10.1 - option: inserting the implant with the smallest diameter according to Figure 9;

Step 10.2 - option: inserted implant with the smallest diameter according to Figure 9;

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Figure 12:

Step 10 - visual checking of the *first* step bore provided (taking over Figure 11, step 10);

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Step 11 - insertion of the *second* step drill according to Figure 3A into the existing *first* step bore;

Step 12 - producing the *second* step bore to the full drilling depth;

Step 13 - checking the drilling depth with the depth gage according to Figure 7 for the *second* step drill;

Step 14 - visually checking the *second* step bore provided;

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Step 14.1 - option: insertion of the implant with the medium diameter;

Step 14.2 - option: inserted implant with the medium diameter;

Figure 13:

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Step 14 - visual checking of the *second* step bore provided (taking over Figure 12, step 14);

Step 15 - insertion of the *third* step drill according to Figure 4A into the existing *second* step bore;

Step 16 - producing the *third* step bore to the full depth;

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Step 17 - checking the drilling depth with the depth gage according to Figure 8 for the *third* step drill;

Step 18 - visual checking of the *third* step bore produced;

Step 18.1 - insertion of the implant with the largest diameter;

Step 18.2 - inserted implant with the largest diameter;

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Figure 14A shows a representation of all the drilling cross sections one above the other;

Figure 14B shows a representation of all the drilling cross sections with designation of the diameters of the guide and the neck that match one another; and

Figure 14C shows the tip of the implant with the largest diameter lying in the drilling cross section of the *third* step drill.

Exemplary embodiments

The following statement applies to the entire further description: where reference numerals are contained in a figure to clarify the drawing but are not explained in the directly associated text of the description, reference is made to where they are mentioned in previous descriptions of figures. In the interest of overall clarity, components are not usually designated by reference numerals repeatedly in the same figures or in subsequent figures if it is clearly evident from the drawing that they are "recurrent" components.

Figures 1A and 1B

The pilot drill **1** serves for the preparation of a step bore in the form of a blind hole, to be introduced into a jawbone, for receiving a dental implant. At the apical end of the pilot drill **1** there is the pilot tip **10**, with the tip cutting edges **101** arranged on it, which form the tip angle α . A pilot guide **11** extends from the pilot tip **10** in the direction of the coronal end of the pilot drill **1**. Lying above the pilot guide **11** is the drill neck **12**, which has a larger drill diameter **b2** than the drill diameter **b1** of the pilot guide **11**. The drill neck **12** is adjoined by the drill stem **13**, and provided at the coronal end of the pilot drill **1** is a standardized dental coupling **14**, which serves for reception in a dental hand-piece, as is typical on drilling engines. Present are at least one guide cutting edge **112**, lying to the side of the pilot guide **11**, a step **124** – as a transition from the pilot guide **11** to the drill neck **12** –, at least one step cutting edge **125** at the step **124** and at least one spiral groove **122** as well as an adjacent bevel **123**.

The tip cutting edges **101** at the pilot tip **10** are sharply formed and center-cutting. From the tip cutting edges **101** there extend chamfers **111**, upward of the pilot guide **11**. The step cutting edges **125** at the step **124** are formed in a cutting manner, while the guide cutting edges **112** are blunt, non-cutting. The entire drill neck **12** with the bevel **123** is formed in a weakly cutting manner. The pilot guide **11** has a length **l1** in the range from 1.0 mm to 4.0 mm.

The pilot drill **1** is preferably formed with two cutting edges and consequently has two tip cutting edges **101**, two chamfers **111**, two guide cutting edges **112**, two spiral grooves **122**, two bevels **123** and two step cutting edges **125**. The drill neck **12** has a length at least equal to the depth of insertion of the implant to be applied, and the pilot guide **11** has a length **l1** of 3.0 mm. The pilot guide **11** has a diameter **b1** in the region of 1.5 mm and the drill neck **12** has a diameter **b2** in the region of 2.0 mm. The tip angle α lying between the tip cutting edges **101** is less than 90°; α preferably lies in the region of 80°. The spiral grooves **122** extend continuously from the coronal end of the drill neck **12** into the pilot tip **10**. The spiral grooves **122** have at the pilot guide **11** only a fraction of their full cross section, as present at the drill neck **12**, as a result of the smaller diameter **b1**. A number of visible depth markings **121** are provided at equal or unequal intervals on the drill neck **12** for checking the drilling depth during the drilling operation.

Figures 2A to 4B

Shown in this sequence of figures are:

- a *first* step drill **2**, with the smallest diameter (Figures 2A and 2B),
- a *second* step drill **2**, with a medium diameter (Figures 3A and 3B), and
- a *third* step drill **2**, with the largest diameter (Figures 4A and 4B).

A step drill **2** serves for the enlargement of a pilot bore in the form of a blind hole, present in a jawbone, into a step bore or for further enlarging an existing step bore into a further enlarged step bore as a receptacle for a dental implant. At the apical end of the step drill **2** lies the step tip **20**, with the two cutting

edges **201**. The step guide **21** extends from the step tip **20** in the direction of the coronal end of the step drill **2**. Lying above the step guide **21** is the drill neck **22**, which has a larger drill diameter **b3,b4,b5** than the drill diameter **b2',b3',b4'** of the step guide **21**. Lying above the drill neck **22** is the drill stem **23**, which is
5 adjoined by a standardized dental coupling **24** as the coronal end. Present are at least one guide cutting edge **212**, lying to the side of the step guide **21**, a step **224** – as a transition from the step guide **21** to the drill neck **22** –, at least one step cutting edge **225** at the step **224** and at least one spiral groove **222** as well as an adjacent bevel **223**. The tip cutting edges **201** at the step tip **20** are
10 sharply formed. From the tip cutting edges **201** there extend chamfers **211**, upward of the step guide **21**. The step cutting edges **225** at the step **224** are formed in a cutting manner, while the guide cutting edges **212** are formed in a blunt, non-cutting manner. The entire drill neck **22** with the bevel **223** is formed in a weakly cutting manner. The step guide with one of the *first*, *second* and
15 *third* step drills **2** has a uniform length **l2,l3,l4** in the region of 2.0 mm.

The step drill **2** is preferably formed with three cutting edges and consequently has three tip cutting edges **201**, three chamfers **211**, three guide cutting edges **212**, three spiral grooves **222**, three bevels **223** and three step cutting edges
20 **225**. The drill neck **22** has a length at least equal to the depth of insertion of the implant to be applied. The step guide **21** on the *first* step drill **2** has a diameter **b2'** in the region of 2.0 mm, while the associated drill neck **22** has a diameter **b3** in the region of 2.8 mm. The step guide **21** on the *second* step drill **2** has a diameter **b3'** in the region of 2.8 mm, its drill neck **22** having a diameter **b4** in
25 the region of 3.5 mm. Finally, the step guide **21** on the *third* step drill **2** has a diameter **b4'** in the region of 3.5 mm and its drill neck **22** has a diameter **b5** in the region of 4.3 mm.

The tip angle β lying between the tip cutting edges **201** is greater than 90°; β
30 preferably lies in the region of 120°. The spiral grooves **222** extent continuously from the coronal end of the drill neck **22** into the step tip **20**. The spiral grooves

222 have at the step guide **21** only a fraction of their full cross section, as present at the drill neck **22**, as a result of the smaller diameter **b2',b3',b4'**. A number of visible depth markings **221** are in turn provided at equal or unequal intervals on the drill neck **22** for checking the drilling depth during the drilling operation.

Figures 5 to 8

Shown in this sequence of figures are:

- a depth gage **3** for the pilot drill **1** (Figure 5),
- a depth gage **3** for the *first* step drill **2** (Figure 6),
- a depth gage **3** for the *second* step drill **2** (Figure 7), and
- a depth gage **3** for the *third* step drill **2** (Figure 8).

The depth gage **3** according to Figure 5 for the pilot drill **1** apically has the guide **31** with the diameter **t1**, the length **k1** and the lowermost tip **30**. The guide **31** is adjoined by the neck **32** with the depth markings **321**. The neck **32** is followed by a holding region **33** with the transition **331** to the head **332**. The diameter **t1** of the guide **31** is equal to or slightly less than the diameter **b1** of the pilot guide **11** of the pilot drill **1**. The length **k1** of the guide **31** is preferably made to be slightly greater than the length **l1** of the pilot guide **11** of the pilot drill **1**. The diameter **t2** of the neck **32** of the depth gage **3** is likewise dimensioned such that it is equal to or slightly less than the diameter **b2** of the drill neck **12** of the pilot drill **1**. The diameters and relative lengths allow the depth gage **3** to be pushed into a borehole without any problem, to measure the depth, and the effective depth of the borehole produced can be reliably determined by ascertaining the depth of penetration from the depth marks **321**.

The depth gage **3** according to Figure 6 for the *first* step drill **2** has at its guide **31** the diameter **t2'**, which is equal to or slightly less than the diameter **b2'** at the step guide **21** of the *first* step drill **2**. The length **k2** of the guide **31** is preferably minimally greater than the length **l2** of the step guide **21** of the step

drill **2**. The diameter **t3** of the neck **32** is likewise equal to or slightly less than the diameter **b3** of the drill neck **22** of the *first* step drill **2**.

The depth gage **3** according to Figure 7 for the *second* step drill **2** has at its guide **31** the diameter **t3'**, which is equal to or slightly less than the diameter **b3'** at the step guide **21** of the *second* step drill **2**. The length **k3** of the guide **31** is minimally greater than the length **l3** of the step guide **21** of the step drill **2**. The diameter **t4** of the neck **32** is likewise equal to or slightly less than the diameter **b4** of the drill neck **22** of the *second* step drill **2**.

The depth gage **3** according to Figure 8 for the *third* step drill **2** is created in an analogous way. The guide **31** has the diameter **t4'**, which corresponds to the diameter **b4'** at the step guide **21** of the *third* step drill **2**. The length **k4** of the guide **31** corresponds to the length **l4** of this *third* step drill **2**, and the diameter **t5** at the neck **32** corresponds to the diameter **b5** at the drill neck **22** of the *third* step drill **2**.

Figure 9

The implant **4** is of a form known per se and begins apically with the tip **41**, which is followed firstly by a stem **42** and, at the coronal end, by a neck **43**. From the tip **41** there extends a thread-cutting geometry **44** into the stem **42**, which is provided with an external thread **421** and has the core diameter **i3**. Stronger implants **4** have the core diameter **i4** or **i5** (see Figures 12 and 13). Of special significance in relation to the bore to be created in the jawbone are the rounded portion **411** at the implant tip **41** and the cone **412** with the cone cutting region **441** and also the thread cutting region **442**. This geometry achieves the effect of an exact fit for the implant **4** when it is screwed into a bore correspondingly prepared in the jawbone, with the bone chips thereby produced, without any major cavities and without excessive bone compression.

Figure 10

The handling with the pilot drill **1** and the associated depth measuring gage **3** is now explained. The situation in the mouth is in this case schematically represented by the jawbone **5**, i.e. without the gingiva. It is assumed that the pilot drill **1** is inserted in the handpiece of a customary dental drilling engine.

Step 1

Using the pilot drill **1** – with its diameter **b1** at the pilot guide **11** and the diameter **b2** at the drill neck **12** – the cortical bone **51**, under which lies the cancellous bone **52** is drilled through at the intended position in the jawbone **5** with the pilot tip **10**. The pilot drill **1** is oriented in the drilling direction **R**. During drilling, the surgeon feels an increased resistance as soon as the step **124** rests on the cortical bone, which he uses as an indication for him to interrupt the drilling process and move on to the second step.

Step 2

A visual check is performed of the position of the pilot bore **61** that has started to be introduced into the jawbone **5**, with the produced pilot bore tip **610** and pilot bore guide **611**, which passes through the hard cortical bone **51**. In particular, it is checked whether the drilling direction **R** is according to plan. The pilot guide **11** with the pilot tip **10** are therefore intended to fix the position of the step bore **62,63,64** that is subsequently to be produced, by introducing a start of a pilot bore **61** through the cortical bone **51**.

Step 3

The still stationary pilot drill **1** is placed once again into the begun pilot bore **61**. Within a conical range of correction **K**, the planned drilling direction **R** is determined in relation to the surrounding situation in the mouth and the further drilling operation is started, whereby the definitive drilling direction **R** is fixed. The blunt guide cutting edges **112** make this correction possible without widening the pilot bore guide **611**.

Step 4

The pilot bore **61** in the possibly corrected drilling direction **R** is then produced in its full drilling depth. The penetration into the cancellous bone **52** can be checked from the depth markings **121**.

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Step 5

The associated depth gage **3** with the diameter **t2** at the neck **32** is inserted into the pilot bore **61** and the pilot bore **61** produced is checked for its exact depth by ascertaining the depth of penetration by reading off from the depth markings **321**.

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Step 6

The pilot bore **61** produced, with the pilot bore tip **610** lying at the bottom of the bore, the adjoining pilot bore guide **611** and the pilot bore neck **612**, which rises up in the coronal direction and opens out at the cortical bone **51**, is visually checked.

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Figure 11

This is followed by the handling with the *first* step drill **2** and the depth measuring gage **3** corresponding to it. It is assumed that the *first* step drill **2**, and possibly the subsequently used *second* and *third* step drills **2**, is fitted in a dental handpiece.

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Step 6

The pilot bore **61** produced is visually checked (taking over step **6** from Figure 10).

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Step 7

Of the *first* step drill **2** – with the diameter **b3** at the drill neck **22** – the step guide **21** with the drilling diameter **b2'** is inserted into the pilot bore **61** and is checked for correct alignment.

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Step 8

The drilling process is started and a *first* step bore **62** is drilled out to the full depth. Optimum centering in the pilot bore **61** is ensured by the step guide **21** present on the step drill **2**, the guide cutting edges **212** of which are blunt, and the laterally non-cutting drilling neck **22**. Lateral drifting of the bore is ruled out in principle. By being formed with three cutting edges, the step drill **2** has excellent centering properties. The step **224** with the step cutting edges **225** brings about the effect that the pilot bore **61** with the diameters **d1/d2** is widened to the diameters **d2/d3**.

Step 9

The associated depth gage **3** with the diameter **t3** at the neck **32** for the *first* step drill **2** is inserted into the *first* step bore **62** produced, to check the drilling depth achieved.

Step 10

Visual check of the *first* step bore **62** produced, which is made up of the step tip **620** lying at the bottom of the bore, the then following step guide **621** and the step neck **622**, which rises up in the coronal direction and opens out in the cortical bone **51**.

Step 10.1

An implant **4** with the smallest core diameter **i3** can be inserted into the then existing *first* step bore **62**. As this takes place, the implant **4** itself cuts the internal thread in the jawbone **5**.

Step 10.2

The implant **4** with the smallest core diameter **i3** lies in situ in the first step bore **62**.

Figure 12

If it is intended to use an implant **4** with a larger core diameter than **i3**, this is followed by the procedure with the *second* step drill **2** and the associated depth measuring gage **3**.

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Step 10

The *first* step bore **62** produced is visually checked (taking over step 10 from Figure 11).

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Step 11

Of the *second* step drill **2** – with the diameter **b4** at the drill neck **22** – the step guide **21** with the drilling diameter **b3'** is inserted into the existing *first* step bore **62** and checked for correct alignment.

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Step 12

The drilling process is started and a *second* step bore **63** is drilled out to the full depth. The step **224** with the step cutting edges **225** brings about the effect that the *first* step bore **62** with the diameters **d2/d3** is widened to the diameters **d3/d4** in the *second* step bore **63** created.

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Step 13

The corresponding depth gage **3** with the diameter **t4** at the neck **32** for the *second* step drill **2** is inserted into the *second* step bore **63** produced, to check the drilling depth achieved.

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Step 14

Visual check of the *second* step bore **63** produced, which by analogy with the *first* step bore **62** is made up of the step tip **630**, lying at the bottom of the bore, the following step guide **631** and the step neck **632**, which rises up in the coronal direction.

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Step 14.1

An implant **4** with the medium core diameter **i4** can be inserted into the then existing *second* step bore **63**.

5 Step 14.2

The implant **4** with the medium core diameter **i4** lies in situ in the *second* step bore **62**.

Figure 13

10 If it is wished to use an implant **4** with the largest core diameter **i5**, this is followed by the procedure with the *third* step drill **2** and the associated depth measuring gage **3**.

Step 14

15 The *second* step bore **63** produced was visually checked (taking over step 14 from Figure 12).

Step 15

20 From the *third* step drill **2** – with the diameter **b5** at the drill neck **22** – the step guide **21** with the drilling diameter **b4'** is inserted into the existing *second* step bore **63** and in turn is checked for the correct drilling direction **R**.

Step 16

25 The drilling process was carried out and a *third* step bore **64** drilled to the full depth. The step **224** with the step cutting edges **225** resulted in the effect that the *second* step bore **63** with the diameters **d3/d4** is widened to the diameters **d4/d5** in the *third* step bore **64** created.

Step 17

30 The corresponding depth gage **3** with the diameter **t5** at the neck **32** for the *third* step drill **2** is inserted into the *third* step bore **64** produced, to check the exact drilling depth.

Step 18

Visual check of the *third* step bore **64** produced, which by analogy with the previous step bores **62,63** is made up of the step tip **640**, the step guide **641** and the step neck **642**.

Step 18.1

An implant **4** with the largest core diameter **i5** is inserted into the then existing *third* step bore **62**.

Step 18.2

The implant **4** with the largest core diameter **i5** lies in situ in the *third* step bore **64**.

Figures 14A and 14B

In this schematic representation, all the drilling cross sections **61,62,63,64** lie one above the other, as they are provided in the jawbone **5** in the sequence of the previously described working cycles before the insertion of an implant **4** with the largest diameter **i5**. It is evident that the pilot bore **61** – with the pilot bore tip **610**, the pilot bore guide **611** and the pilot bore neck **612** – is used for centering all the further, subsequently provided step bores **62,63,64** – with the corresponding step tips **620,630,640**, the associated step guides **621,631,641** and step necks **622,632,642** – and that they have the same drilling depth as the said pilot bore.

The diameter **b2** at the drill neck **12** of the pilot drill **1** is at least virtually identical to the diameter **b2'** at the step guide **21** of the *first* step drill **2**. Consequently, at least virtually identical diameters are also obtained for the resultant bores, that is to say for the pilot bore neck **612** and the *first* step guide **621**, which are both denoted by **d2**. The bore diameter **d1** was produced by the pilot guide **11** of the pilot drill **1** with the bore diameter **b1**. The bore diameters **d3** and **d4** originate from the at least virtually identical diameters **b3** at the drill

neck **12** of the *first* step drill **2** and the diameter **b3'** at the step guide **21** of the *second* step drill **2** and from the diameters **b4** at the drill neck **12** of the *second* step drill **2** and the diameter **b4'** at the step guide **21** of the *third* step drill **2**, respectively.

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It may be advantageous to dimension the drill diameter **b2',b3',b4'** at the respective step drill **2** such that it is slightly – for example 1/100 mm to 1/10 mm – less than the drill diameter **b2,b3,b4** at the drill neck **12,22** of the tool previously to be used, which is the pilot drill **1**, the *first* step drill **2** or the *second* step drill **2**. This facilitates the insertion and penetration of the outwardly non-cutting step guide **21** with the blunt guide cutting edges **212** into the pilot neck **612** of the pilot bore **61** or into the step neck **622,632** of the *first* or *second* step bore **62,63**, respectively. A person skilled in the art will determine the actual reduction in diameter of **b2',b3',b4'** with respect to the drill diameters **b2,b3,b4** at the drill neck **12,22** on the basis of, inter alia, the cutting properties of the drill neck **12,22** with the bevel **123,223** and also the step guide **21** with the tip angle β and the guide cutting edges **212**.

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Figure 14C

It is shown in principle how the tip **41** of the implant **4** with the largest diameter **i5** lies in the cross section of the *third* step bore **64** with the diameter **d5**. The rounded portion **411** of the implant tip **41** fits well into the step tip **640** of the *third* step bore **64**. The cross section of the step guide **641** of the present step bore **64** is minimally less than the cross section of the cone **412** of the implant tip **41**. However, in order to introduce the implant **4** into the position shown, it has a cutting edge geometry **44** with a conical cutting-edge region **441**. As a result, particles are cut off from the bone **5** in the region of the cone **412** and the bore cross section is correspondingly widened. These cut-off bone particles are transported into the cutting edge **44** or neighboring regions, where the *third* step bore **64** is minimally larger in cross section than the implant **4** with the largest core diameter **i5** that is used here. This avoids excessive bone compression and achieves optimum primary stability of the tip **41** of the implant **4**.

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directly after implantation. An analogous operation with cut-off bone particles takes place in the region of the external thread **421** of the implant **4** and the step neck **642** of the *third* step bore **64**. The step neck **642** with the diameter **d5** is slightly larger than the core diameter **i5** of the implant **4**, so that space is
5 offered there for bone particles that have been cut off by the thread-cutting region **442** and transported to it.